Coastal and Ocean Resources

MCORI Project: 18-04 **March 2019**

ShoreZone Habitat Mapping Summary Report

Howe Sound/Vancouver Port Survey Area

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Howe Sound/Vancouver Port Area Summary

913 km of shoreline mapped

3,696 shoreline units created

Average unit length of **247 m**

40% of the intertidal is classified as **Sediment-dominated** and **19%** is classed as **Rock**

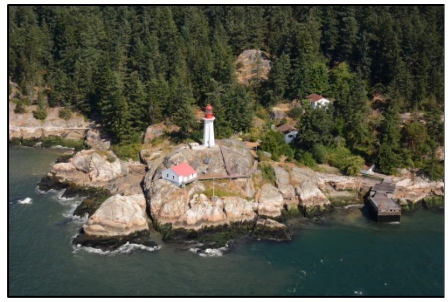
65% of the shoreline has a high Oil Residence Index value (residence of months to years)

55% of the shoreline has a **Shoreline Modification** of some type

13 intertidal biobands were classified, with **Green Algae** and **Barnacle** being the most common (73% and 69% of units respectively)

8 supratidal biobands were classified, with **Black Lichen** being the most common (56% of units)

9 subtidal biobands were classified, with **Sargassum** being the most common (22% of units)



Point Atkinson Lighthouse

Port Mellon

South Fraser River

Indian River Estuary

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1 INTRODUCTION

ShoreZone is an imaging and habitat classification system for the coastal nearshore margin including the shallow subtidal, intertidal shoreline and supratidal fringe. One objective of ShoreZone is to produce a georeferenced, searchable inventory of the physical and biological attributes of coastal habitats. ShoreZone imagery and habitat attributes can provide a useful baseline from which to study change over time, while the attributes mapped (such as shoreline sediments, predicted oil residence and biotic communities) provide an important resource for scientists and managers. The ShoreZone mapping system provides a decision support tool with many potential uses including: community planning, facilities citing, conservation planning, research and fisheries management, emergency planning and response, search and rescue, education and habitat modeling.

The ShoreZone system was developed in the 1980s and 1990s to map coastal habitats in British Columbia and Washington State (Howes 2001; Berry *et al.* 2004). In 2001 ShoreZone was implemented in Alaska, beginning with Cook Inlet, Outer Kenai, Katmai, and portions of the Kodiak Archipelago (Harper and Morris 2004). ShoreZone has since expanded to a spatially continuous database of over 75,000 km of coastal Alaska and 45,000 km of British Columbia, Washington and Oregon (see Figure 1). Figure 2 shows the extent of the shoreline mapped around Vancouver survey area and is the section of shoreline covered by this summary report.

The ShoreZone imaging surveys conducted in Burrard Inlet in July 2017, Howe Sound in June 2018, and around Vancouver September 2018 acquired aerial video and digital still images of the coast during minus tides (zero-meter tide levels and lower). The imagery and associated audio commentary were used to map the physical and biological attributes of the shoreline according the most recent ShoreZone coastal habitat mapping protocol (Cook *et al*. 2017). The purpose of this report is to provide a summary of the physical (Section 2) and biological (Section 3) data imaged and classified in the Vancouver survey area.

The length of shoreline mapped is 913 kilometers in 3,696 along-shore segments (units), averaging 247 m in length. The digital shoreline used for the ShoreZone habitat mapping was compiled from multiple sources to create the best available representation of the current shoreline. The primary source for this project was the CHS Pacific High-Water Coastline 2014 BC Albers.

Figure 1. Extent of ShoreZone imagery in Alaska, British Columbia, Washington State and Oregon as of April 2019. Some sections of the coastline in BC have been imaged more than once.

Figure 2. Extent of mapping in the Vancouver survey area.

2 PHYSICAL ATTRIBUTE DATA SUMMARY

2.1 Coastal Class

Figure 3. Map of the Coastal Class categories (also known as Shore Type) in the Howe Sound/Vancouver Port region, grouped by type.

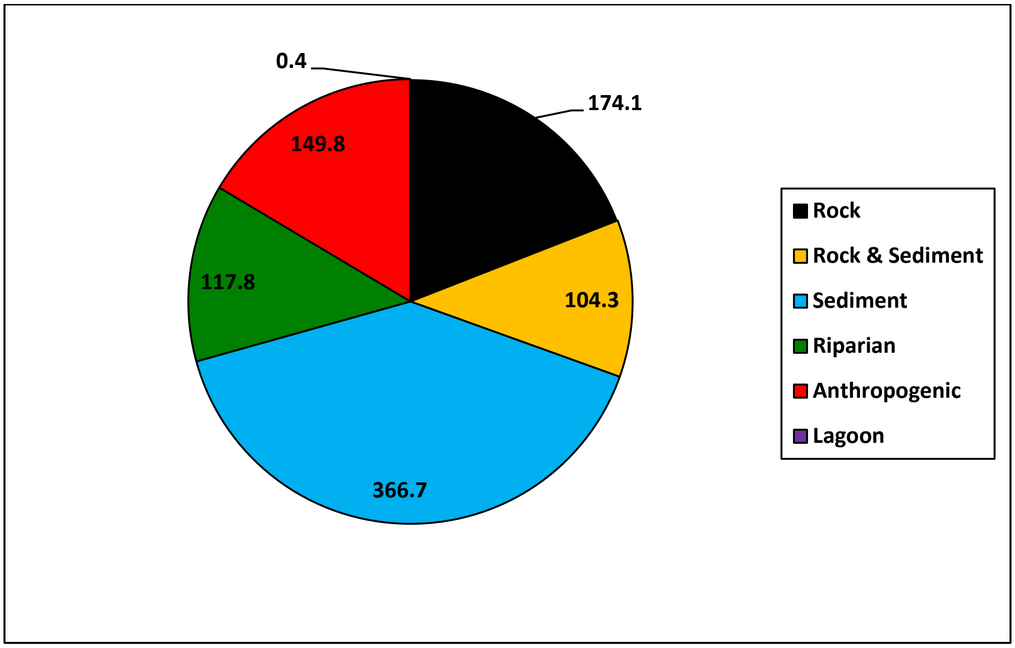

Figure 4. Grouped Coastal Class categories by shoreline length (km).

The Coastal Class is used to define along-shore coastal units based on the dominant process, geomorphic features and other attributes such as substrate size, across-shore width, and slope (Cook *et al*., 2017 after Howes *et al.* 1994). The principal characteristics of each along-shore unit are used to assign one of 39 overall unit classifications. Sediment shorelines (40.2%) and Rock shorelines (19.1%) dominated the Vancouver area. Anthropogenic shorelines followed with 16.4% and mixed Rock and sediment shorelines were found along 11.4% of the coast (see Figures 3 and 4 for distribution and summary statistics). The description for each Coastal Class category in the survey area is given in Table 1. Photographic examples of the major Coastal Classes mapped in the Vancouver study area are found in Appendix A, Table A-1.

Table 1. Summary of the Coastal Class attribute for the Vancouver survey area.

Substrate Type	Shore Type No.	Shore Type Description	Sum of Unit Length (km)	# of Units	% Occurrence (by length)	Cumulative Occurrence (%, km)
Rock	1	Rock Ramp, wide	<1	1	<1	**19.1% 174.1 km**
	2	Rock Platform, wide	<1	2	<1	
	3	Rock Cliff	159	707	17	
	4	Rock Ramp, narrow	15	121	2	
Rock & Sediment	6	Ramp with gravel beach, wide	<1	1	<1	**11.4% 104.3 km**
	7	Platform with gravel beach, wide	<1	1	<1	
	8	Cliff with gravel beach	35	247	4	
	9	Ramp with gravel beach	15	125	2	
	11	Ramp w gravel & sand beach, wide	6	55	1	
	12	Platform with G&S beach, wide	9	43	1	
	13	Cliff with gravel/sand beach	13	104	1	
	14	Ramp with gravel/sand beach	23	195	3	
	15	Platform with gravel/sand beach	<1	3	<1	
	17	Platform w sand beach, wide	1	5	<1	
	18	Cliff with sand beach	<1	3	<1	
	19	Ramp w sand beach, narrow	<1	1	<1	
Sediment	22	Gravel beach, narrow	7	61	1	**40.2% 366.7 km**
	24	Sand & gravel flat or fan	86	313	10	
	25	Sand & gravel beach, narrow	96	516	11	
	27	Sand beach	<1	1	<1	
	28	Sand flat	66	104	7	
	29	Mudflat	64	149	7	
	30	Sand beach	49	155	5	
Organics	31	Organics/Estuarine	118	235	13	**12.9% 117.8km**
Man-made	32	Man-made, permeable	128	475	14	**16.4% 149.8 km**
	33	Man-made, impermeable	22	70	2	
Lagoonal	36	Lagoons	<1	2	<1	**0.0% 0.4 km**
Totals:			***913***	***3,696***	***100***	***100%***

Note: This table only includes Coastal Classes observed in the Vancouver survey area.

2.2 Environmental Sensitivity Index (ESI)

Figure 5. Distribution of the grouped ESI categories from least to most sensitive to oiling.

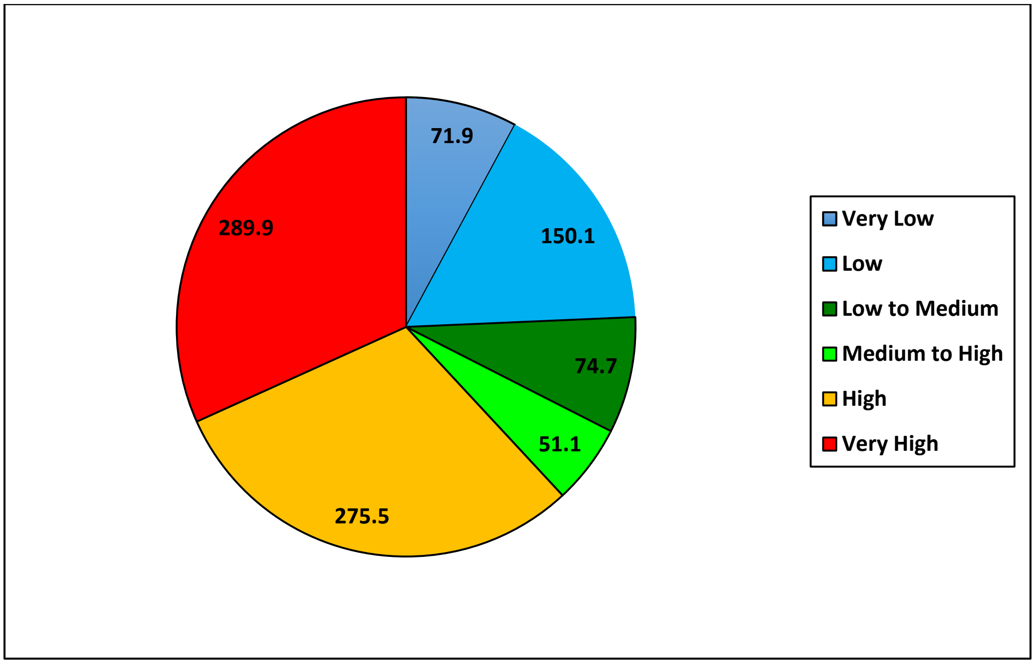

Figure 6. Grouped most sensitive ESI categories by shoreline length (km).

The NOAA Environmental Sensitivity Index (ESI) is a shoreline classification system developed to characterize coastal regions based on sensitivity to potential oil spills (Petersen *et al*. 2002). The ESI system uses wave exposure and principal substrate type to assign a rank of 1 to 10 (with 10 being the most sensitive to oil) to alongshore units. Up to three ESI numbers can be assigned to each ShoreZone unit (high, mid and low intertidal) if applicable. The highest ESI number for each unit, which is the most sensitive, is used in this analysis.

The Vancouver study area is dominated by the grouped High and Very High categories (61.9% of shoreline length). These sections of the shoreline have a potentially high sensitivity to oil. At the other end of the spectrum, only 24.3% of the shoreline was mapped with a potentially low sensitivity to oil (Figures 5 and 6). The summary of Shore Type by ESI class can be seen in Table 2.

Table 2. Summary of Shore Types by ESI Class for the Vancouver survey area.

Environmental Sensitivity Index (ESI)		Sum of Unit Length (km)	# of Units	% of Total Shoreline Length
No.	**Description**			
1A	Exposed rocky shores; Exposed rocky banks	54	249	6
1B	Exposed, solid man-made structures	4	12	<1
1C	Exposed rocky cliffs with boulder talus base	4	36	<1
2A	Exposed wave-cut platforms in bedrock, mud, or clay	11	85	1
3A	Fine- to medium-grained sand beaches	10	40	1
4	Coarse-grained sand beaches	<1	1	<1
5	Mixed sand and gravel beaches	140	790	15
6B	Gravel beaches (cobbles and boulders)	12	109	1
6C	Rip rap	63	254	7
7	Exposed tidal flats	51	82	6
8A	Sheltered scarps in bedrock, mud, or clay; sheltered rocky shores (impermeable)	130	678	14
8B	Sheltered, solid, man-made structures; sheltered rocky shores (permeable)	67	243	7
8C	Sheltered Rip Rap	34	123	4
8D	Sheltered rocky rubble shores	45	305	5
9A	Sheltered tidal flats	59	197	6
10A	Salt- and brackish-water marshes	231	492	25
	Totals:	***913***	***3,696***	***100%***

Note: ESI Classes not observed in this survey area were not included in the table.

2.3 Oil Residence Index (ORI)

Figure 7. Distribution of the Oil Residence Index (ORI) categories.

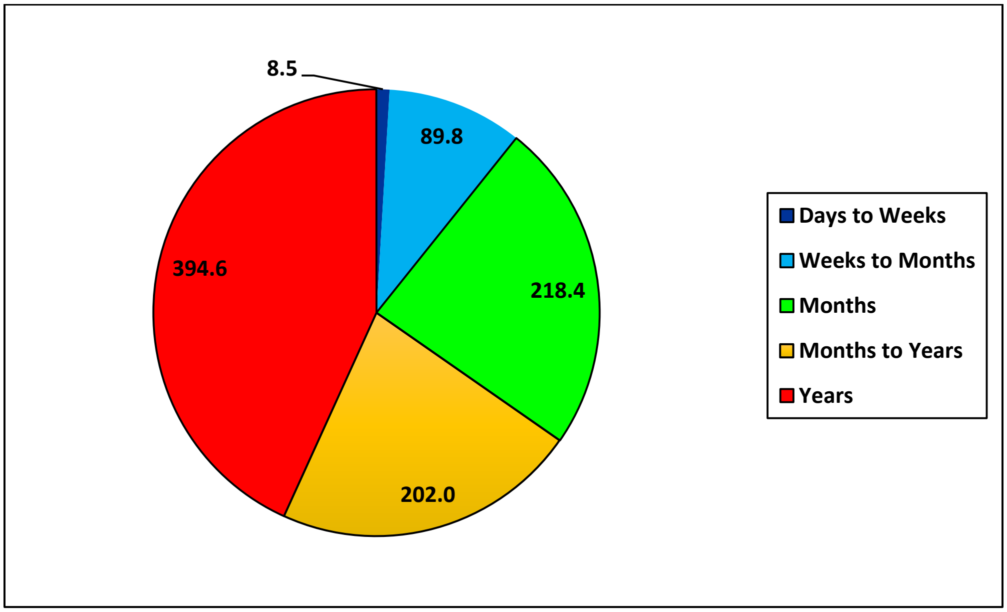

Figure 8. Oil Residence Index (ORI) categories by shoreline length (km).

The Oil Residence Index (ORI) is a rating between 1 and 5 with a value of 1 indicating a relatively short oil residence (days to weeks) while a value of 5 reflects potentially very long oil residence times (years). An ORI value is applied to each alongshore unit and to each across-shore component based on sediment texture and wave exposure (Cook *et al*. 2017). The ShoreZone ORI was developed by Dr. John Harper based on his many years of experience with cleaning up oiled shorelines, starting with the Exxon Valdez spill in Prince William Sound in Alaska. Lower wave exposures and unconsolidated sand and gravel sediments lead to high ORI values for 65.3% of the shore segments around Vancouver, indicating oil residence times are on the order of months to years (see Figures 7 and 8 for distribution and summary statistics).

2.4 ShoreZone Coastal Vulnerability

2.4.1 Flood Zone Width

Figure 9. Distribution of the Coastal Vulnerability Flooding Class.

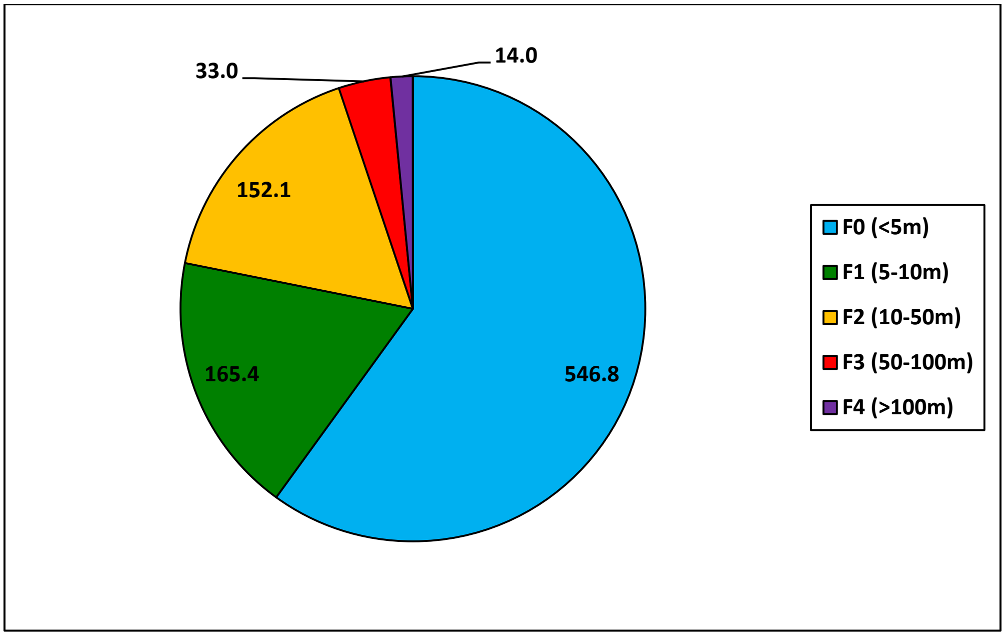

Figure 10. Flooding Class categories by shoreline length (km).

The Coastal Vulnerability Module (CVM) includes a classification of flooding sensitivity based on the across shore profile and photographic evidence of historical flooding such as an unambiguous marine debris line. The Flooding Class is an estimate of vulnerability to inundation of the terrestrial area beyond the supratidal. The distance to the debris line is measured and used to classify the flooding potential. Flat shorelines with very low gradients that show evidence of historical flooding have a higher risk of being inundated by storm surges. Potential for damage due to flooding is generally low in the study area, with 60.1% of the shoreline at a low risk of flooding <5m from MHW (see Figures 9 and 10 for distribution and summary statistics). The flooding class is a parameter of the Coastal Vulnerability Index (see Page 16).

2.4.2 Coastal Vulnerability Observations

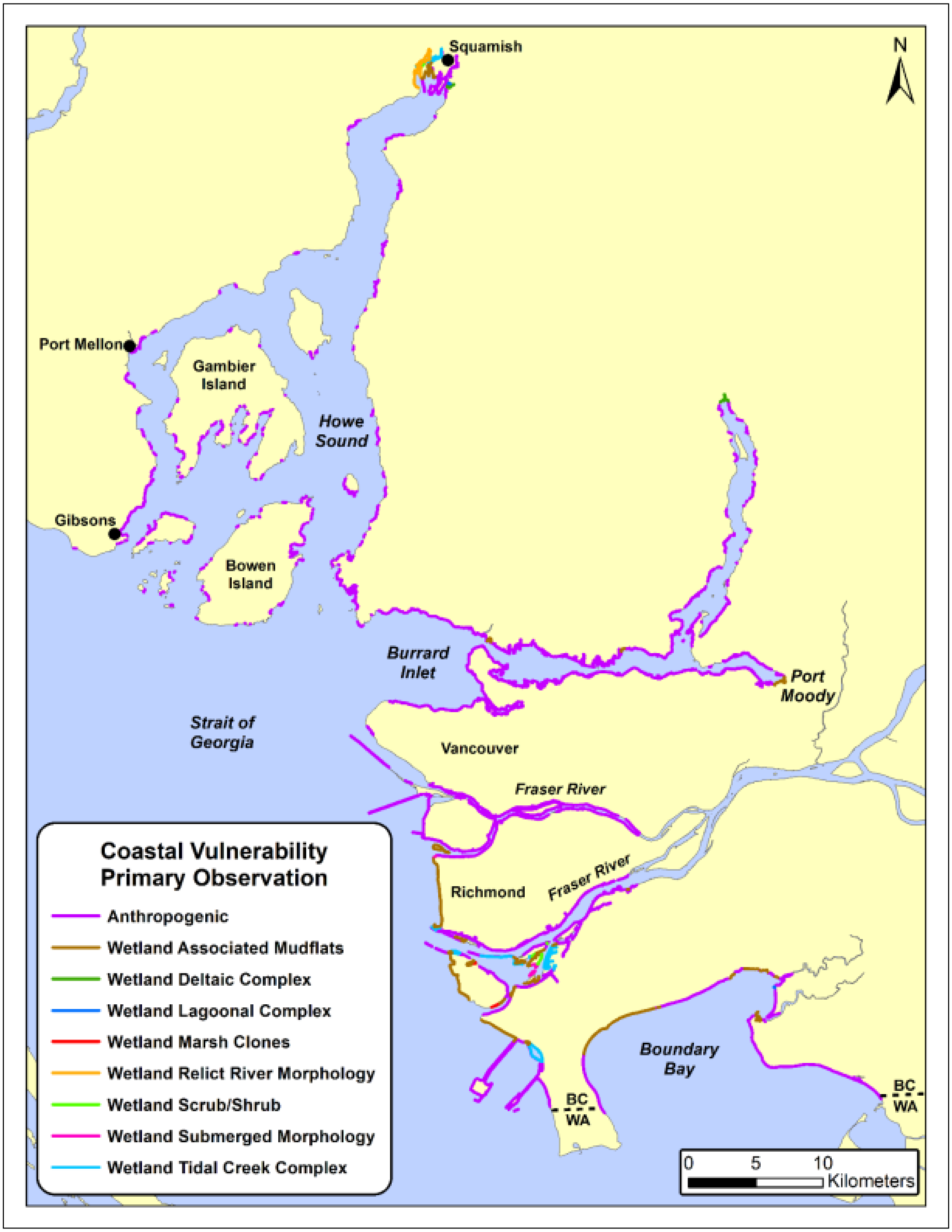

Figure 11. Distribution of the Coastal Vulnerability Observations categories.

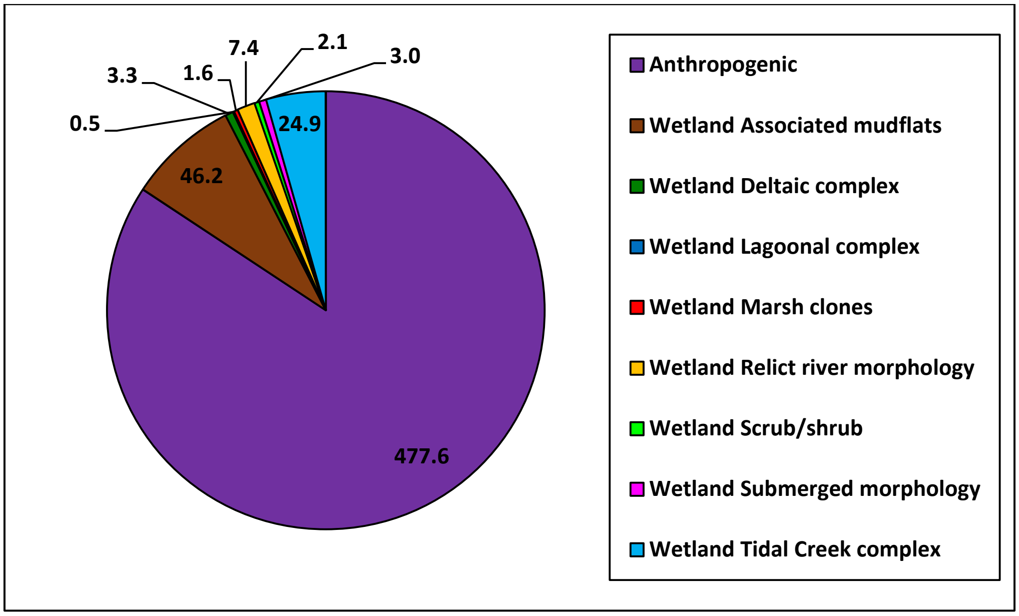

Figure 12. Coastal Vulnerability Observation categories by shoreline length (km). Category 'None' not shown.

The Coastal Vulnerability Module of ShoreZone includes several attributes to provide qualitative estimates of the vulnerability of a unit to impact from sea level rise, whether that is due to anthropogenic causes or natural phenomena such as storm surge (Cook *et al*. 2017). One of these attributes is an observation of features important for estimating the potential impact of coastal inundation based on the condition of the shoreline in the supratidal. Natural shorelines are, generally, considered to be more resilient to inundation due to features such as marshes or dunes while shoreline hardening, or modification can cause the shore to lose resiliency. These observations are meant to complement the 'Anthropogenic' Coastal Class (Page 4) which indicates significant modification of the intertidal and the Shoreline Modifications attribute (Page 17) which catalogues the type of modifications observed (supratidal or intertidal). In the Vancouver study area, apart from the 'None' category, the majority of observations were from the Anthropogenic category with 477.6 km (see Figures 11 and 12 for distribution and summary statistics). It is important to point out that these areas are not necessarily areas of vulnerability, but areas that could have reduced resilience.

2.4.3 Coastal Vulnerability Index

The methods of Thieler and Hammer-Klose (2000) ((http://woodshole.er.usgs.gov/project-pages/cvi/) were adapted to calculate the Coastal Vulnerability Index (CVI) using five ShoreZone attributes: Shore Type, Max Tide Range, Shoreline Erosion index, Flood Zone Width, and Wave Height. See the most recent ShoreZone protocol for more details (Cook *et al*., 2017). When we first attempted to calculate the CVI for the portion of the shoreline funded in the Eastern Aleutians by OSRI, it did not match the observations of the mappers as it appeared to rank too much of the rocky, steep shoreline as High or Very High in terms of vulnerability to sea level rise. After analysis of the data, we determined this was due to using a relative ranking system where the values from the study area were only compared to each other to determine the CVI rank. To resolve this issue we calculated an absolute value for each CVI rank which is described in the latest version of the protocol (Cook *et al*., 2017). The distribution of ranks in the survey area is shown in Figure 13. The presence of so much anthropogenic modification in the survey area was not something present in the areas where the CVI was developed and may make the results more challenging to interpret.

Figure 13. Distribution of Coastal Vulnerability index ranks in the Howe Sound/Vancouver Port region.

2.5 Anthropogenic Shoreline Modifications

Figure 14. Distribution of types of the primary Shore Modifications. There may be other shore modifications in any given unit. That data would be found in the Shore Modifications table in the geodatabase.

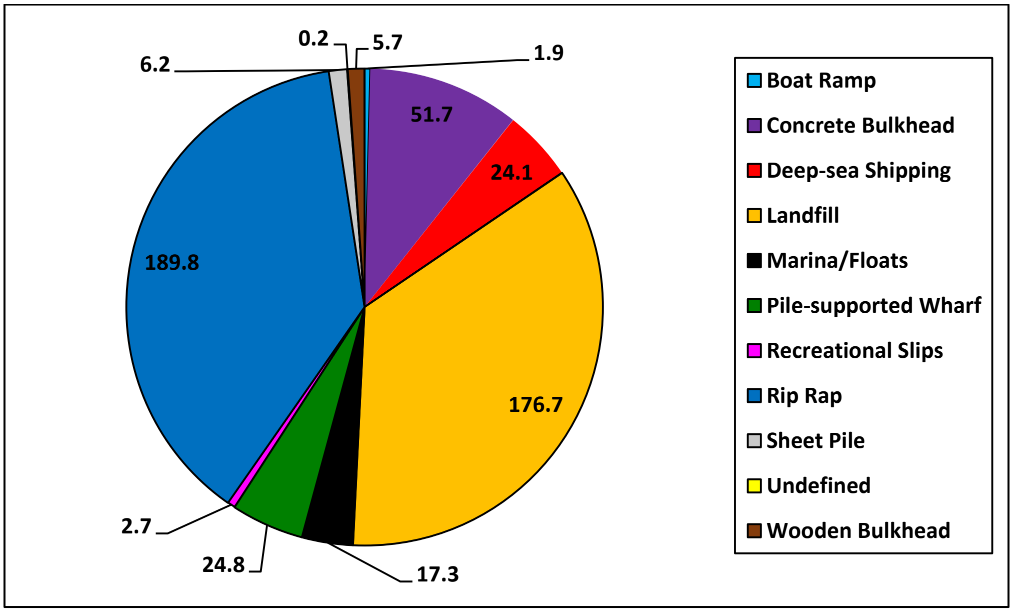

Figure 15. Shore Modifications by estimated shoreline length (km) of each modification type.

The Shoreline Modification attribute provides a thorough catalogue of the specific types of anthropogenic modification in each unit (Cook *et al*., 2017). This includes many modifications within a given unit. For example, if both riprap and a pile-supported wharf occur, both are catalogued in the appropriate zone of that unit with an estimate of the alongshore length of the unit that modification covers. A total of 54.9% of the shoreline (taking the estimated length of that modification within the unit into account) exhibits shore modifications in the Vancouver study area (Figure 15). Rip Rap was the most commonly recorded observation (37.9%) with Landfill along 35.3% of the shore and Concrete Bulkheads along 10.3%. The associated map (Figure 14) shows the distribution of primary shore modifications though it should be noted that any given modification isn't necessarily along the entire length of the indicated shore unit. The Geodatabase delivered with this report displays each shore modification with a specific length category (meters) along the shoreline pertaining to each unit as well as the specific zone (supratidal or intertidal) the modification occurs in.

3 BIOLOGICAL ATTRIBUTE DATA SUMMARY

3.1 Biobands

Biobands represent assemblages of coastal biota found on the shoreline at typical wave exposures, substrate conditions and across-shore elevations. Biobands are spatially distinct, with alongshore and across-shore patterns of color and texture that are visible in aerial imagery (see Appendix A, Table A-2 for examples from the Howe Sound/Vancouver Port survey area). Full descriptions of all biobands, including indicator and associated species can be found in the ShoreZone protocol (Cook *et al*. 2017). The metrics for measuring the biobands are also detailed in the protocol document. The specific elevation (or zone) of the bioband on the shoreline determines the metrics applied. Biobands found in the supratidal (A Zone) and subtidal (C Zone) are described by percent of alongshore length of unit and a width category. The intertidal (B zone) biobands are described by percent of alongshore length of the unit and percent cover of the zone.

The 26 individual biobands mapped in the Howe Sound/Vancouver Port survey area are summarized in Tables 3 and 4. The survey area had a significant gradient in both physical and biological characteristics from south to north, with the southern area dominated by wide sediment beaches and anthropogenically modified shoreline around the mouth of the Fraser River and in Burrard Inlet while Howe Sound and Indian Arm have narrower, rockier shorelines. That gradient of sediment type and fresh water influence strongly influenced the distribution of biota in the region. The most commonly occurring intertidal biobands were Green Algae (72.9% of units), Barnacle (68.9% of units) and Rockweed (60.3% of units) which were strongly correlated with the rocky shoreline in Howe Sound and the hard anthropogenic substrate such as riprap, pilings and wharves in the southern portion of the region.

The most common Splash Zone bioband was Black Lichen, occurring in 56.0% of the units. Dune Grass and Salt Marsh were less common than might be expected in an area that encompasses an estuarine system such as Burrard Inlet and the mouth of the Fraser River, at 6.0% and 16.0% of units, respectively (see Figure 16 for distribution of Salt Marsh). This is likely due to the high percent of units with shore hardening and modifications in the supratidal zone as well as the inclusion of the rocky shoreline in Howe Sound. Canopy Kelps were rare, only occurring in 2.6% of units and almost exclusively within Burrard Inlet. See the following paragraphs for detailed discussions of some of the biological trends observed and maps of the distribution of specific biobands.

Table 3. Percent cover category for the intertidal biobands in the Howe Sound/Port of Vancouver survey area.

Bioband		Zone	Number of Units							Total Number of Units* With Bioband Present	% of Total Units* with Bioband Present
			Percent Cover Category (Intertidal Zone)								
Name	Code		<5%	5-25%	26-50%	51-75%	76-95%	>95%	Bioband present, Percent Cover Not Assessed		
Salt Marsh (BC)	SAMB	Upper to Mid Intertidal	13	269	104	79	25	0	0	490	13.3%
Spartina	SPAR		0	0	0	0	0	0	1	1	0.0%
Barnacle	BARN		41	2145	338	5	0	0	19	2548	68.9%
Rockweed	ROCK		73	1946	187	18	0	0	4	2228	60.3%
Biofilm	BIOF			2	1	0	0	0	0	3	0.1%
Blue Mussel	BLMU		131	1632	114	5	0	0	9	1891	51.2%
Green Algae	GRAL		107	2364	192	25	2	0	6	2696	72.9%
Bleached Red Algae	BRAL	Mid to Lower Intertidal	0	1	0	0	0	0	0	1	0.0%
Filamentous and Foliose Red Algae	FFRA		68	1002	3	1	0	0	0	1074	29.1%
Diatoms	DIAT		0	13	4	1	0	0	0	18	0.5%
Coralline Red Algae	CORA		0	1	0	0	0	0	0	1	0.0%
Bladed Brown Kelps	SOBK/ BRBA		71	417	5	0	0	0	3	496	13.4%
Eelgrass	EELG		12	39	20	14	1	0	34	120	3.2%

*Please note that Total Number of Units is used to describe the distribution of biobands rather than length (in kilometers) because biobands are usually not continuous along the entire length of a unit. A calculation could be performed to estimate length of a bioband over a region using the percent length metric in the dataset.

Table 4. Width category of supratidal and subtidal biobands in the Howe Sound/Port of Vancouver survey area.

Bioband		Zone	Number of Units				Total Number of Units* With Bioband Present	% of Total Units* with Bioband Present
			Width Category					
Name	Code		<1 m	1-5 m	>5 m	Bioband present, Width Not Assessed		
Splash Zone	SPZO	Splash Zone (A)	549	199	1	2	751	20.3%
Black Lichen	BLLI		1110	929	31	0	2070	56.0%
Unidentified Lichen	LICH		42	118	7	0	167	4.5%
White Lichen	WHLI		67	91	13	0	171	4.6%
Yellow Lichen	YELI		5	8	0	0	13	0.4%
			<10 m	10-30 m	>30 m	Bioband present, Width Not Assessed		
Grasses	GRAS	Supratidal (A)	37	2	0	0	39	1.1%
Dune Grass	DUGR		204	14	4	0	222	6.0%
Salt Marsh	SAMB		429	81	81	2	593	16.0%
Green Algae	GRAL	Subtidal (C)	0	0	0	46	46	1.2%
Eelgrass	EELG		21	15	23	15	74	2.0%
Brown Bladed Kelps	SOBK/DABK/BRBA		254	20	4	180	458	12.4%
Sargassum	SARG		719	61	2	41	823	22.3%
Brown Canopy-Forming Algae	BRCA		0	1	0	0	1	0.0%
Bull Kelp	BUKE		79	9	7	0	95	2.6%
Urchin Barrens	URBA		0	1	0	0	1	0.0%

*Please note that Total Number of Units is used to describe the distribution of biobands rather than length (in kilometers) because biobands are usually not continuous along the entire length of a unit. A calculation could be performed to estimate length of a bioband over a region using the percent length metric in the dataset.

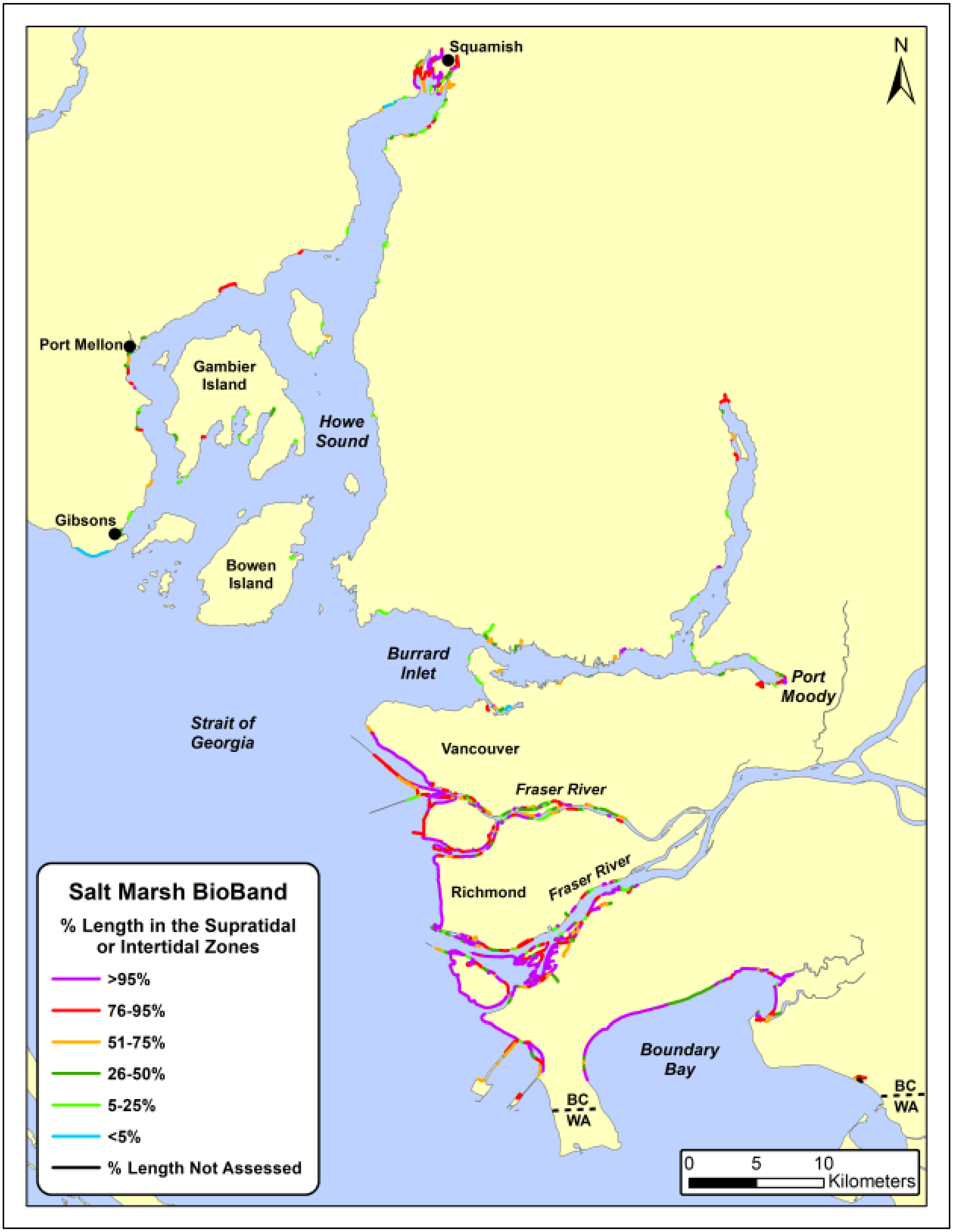

Figure 16. Distribution of the Salt Marsh bioband in the supratidal zone and intertidal zone in the Howe Sound/Vancouver Port survey area. The highest length category is shown in the map if different lengths for supratidal and intertidal were observed.

Eelgrass was recorded in the intertidal in 3.2% of units and in the subtidal in 2.0% of units so it was not common in the survey area, although it was much more common to the south, on the mudflats around Tsawwassen and Boundary Bay. The Eelgrass bioband appeared to be almost absent from the Howe Sound area. We also compared the distribution of Eelgrass as mapped from ShoreZone imagery with the 2015 Burrard Inlet-Indian Arm Eelgrass Mapping report (Rao 2015). ShoreZone captured the larger beds but missed some of the small, patchy subtidal beds in Indian Arm. Upon review of the imagery it was determined those beds were not visible on the day the imagery was taken due to the murky conditions immediately off the beach (see Figure 17 for an example). See Figure 18 for a map of the distribution of Eelgrass in the survey area from the ShoreZone observations.

Figure 17. Example of murky subtidal conditions during the ShoreZone imaging survey in July 2017. The shallow subtidal is not visible in this image so ShoreZone mapping was not able to capture the bed that Rao (2015) indicated was in the shallow subtidal here.

Eelgrass was noted at Spanish Banks during the Burrard Inlet habitat mapping project, although it had not historically been recorded as an area with eelgrass habitat. This was confirmed to be *Zostera japonica*, an introduced eelgrass that occurs higher in the intertidal than the native *Z. marina*, during a ShoreZone ground survey conducted in June 2018 (Cook and Daley 2019). Both species were also noted in high abundance on the mudflat near the Tsawwassen Ferry Terminal during that ground survey. The literature on Z. japonica has shown positive impacts of the spread of this introduced species for waterfowl (Baldwin and Lovvorn 1994) while Sutherland *et al*. (2013) showed positive impacts for some species, such as salmon and waterfowl, and surmised potential negative impacts for other waterfowl that require non-vegetated mudflats for feeding. The specific impacts of these introduced species on specific native species of concern (such as those used for subsistence harvesting) should be investigated further. The native and introduced species cannot be distinguished from the aerial imagery so if the distribution of each species is needed, ground surveys and subtidal surveys could be conducted.

Figure 18. Distribution of the Eelgrass bioband in the intertidal zone and subtidal zone in the Howe Sound/Vancouver Port survey area. The units where both intertidal and subtidal Eelgrass was observed are in red.

Another introduced species in the Howe Sound/Vancouver Port area that is able to be distinguished from aerial imagery is the Sargassum band, which is defined by the presence of Japanese Wireweed (*Sargassum muticum*). The Sargassum band was observed in 22.3% of the units, mostly in southern Howe Sound and parts of Burrard Inlet. The Vancouver ShoreZone ground survey team observed that Sargassum was common in Burrard Inlet but often mixed with other species and not necessarily as a distinct band distinguishable from the aerial imagery (Cook and Daley 2019), so the species is assumed to be more widely distributed than the Bioband (see Figure 19 for map). There is significant literature available on the impacts of introduced Japanese Wireweed with somewhat conflicting conclusions, as some studies find negative impacts on native species (DeWreede and Vandermeulen, 1988; Britton-Simmons, 2004) and some finding little to no impacts (Sanchez and Fernandez, 2005; Olebarria *et al*., 2009; Smith, 2015). White (2010) who studied the effects of *S. muticum* on macroalgal communities and grazing invertebrates in BC found that the effects of introduction were both density and time dependent and were mediated through competition for light and also that the effects went in both positive and negative directions.

The biobands that were used to record understory kelps in the survey area include Soft Brown Kelps (SOBK), Dark Brown Kelps (DABK) and Brown Bladed Algae (BRBA), and collectively they were recorded in only 12.4% of units in the subtidal zone in this region. Kelps appear to be mostly absent from the northern portion of Howe Sound and Indian Arm as well as from the more sediment dominated southern portion of the region (Figure 19). This could possibly be related to the effects of sea star wasting disease which lead to a trophic cascade on the rocky reefs in Howe Sound and a dramatic increase in urchin barrens, coupled with a decrease in kelp (Schultz *et al*. 2016). Unlike the northern urchin barrens noted around Prince Rupert (Coastal and Ocean Resources 2019) which are dominated by Purple and Red Sea Urchins (*Strongylocentrotus purpuratus* and *S. fransicanus*), the Howe Sound barrens are created by Green Sea Urchins (*S. droebachiensis*) which are not distinguishable from aerial imagery as they blend in with the rock substrate. So Urchin Barrens were only mapped in 1 unit in Howe Sound, although they can be assumed to be far more widely distributed. If the results of dive or towed camera surveys were used to define the appearance of the Green Urchin Barrens it may be possible to go back over the imagery and map the distribution of this bioband in the future.

The Blue Mussel bioband was noted in just over half the units (51.2% overall) and formed extensive beds on the rock substrate throughout Howe Sound and Indian Arm, around Point Atkinson and on the beaches on the north shore of Burrard Inlet and to the west of the Lions Gate Bridge. This bioband was almost absent from the more sediment dominated southern portion of the region. See Figure 20 for a map of the distribution of Blue Mussels in the survey area.

Figure 19. Distribution of the Sargassum and Brown Bladed Algae biobands by Percent Cover in the intertidal zone in the Howe Sound/Vancouver Port survey area. Please noted, for this map Brown Bladed Algae include three biobands: Soft Brown Kelps, Dark Brown Kelps and Brown Bladed Algae.

Figure 20. Distribution of the Blue Mussel bioband in the Howe Sound/Vancouver Port survey area.

3.2 Biological Wave Exposure

Biological wave exposure categories range from Very Protected (VP) to Very Exposed (VE) and are defined in ShoreZone on the basis of a typical set of biobands. When present, the observation and relative abundance of biota in each alongshore unit is used to determine the classification for the biological wave exposure. The assemblages of biota observed are then used as a proxy for the wave exposure at that site. For definitions of the Biological Wave Exposures and the exposure ranges of the biobands, see the most recent ShoreZone protocol (Cook *et al*. 2017).

The distribution of the wave exposure categories mapped in the Howe Sound/Vancouver Port area are summarized in Figure 21 and a distribution map of the categories is shown in Figure 22. 72% of the coastline was in the low exposure categories of Protected or Very Protected, with another 27% Semi-Protected so this area is characterized by limited wave fetch.

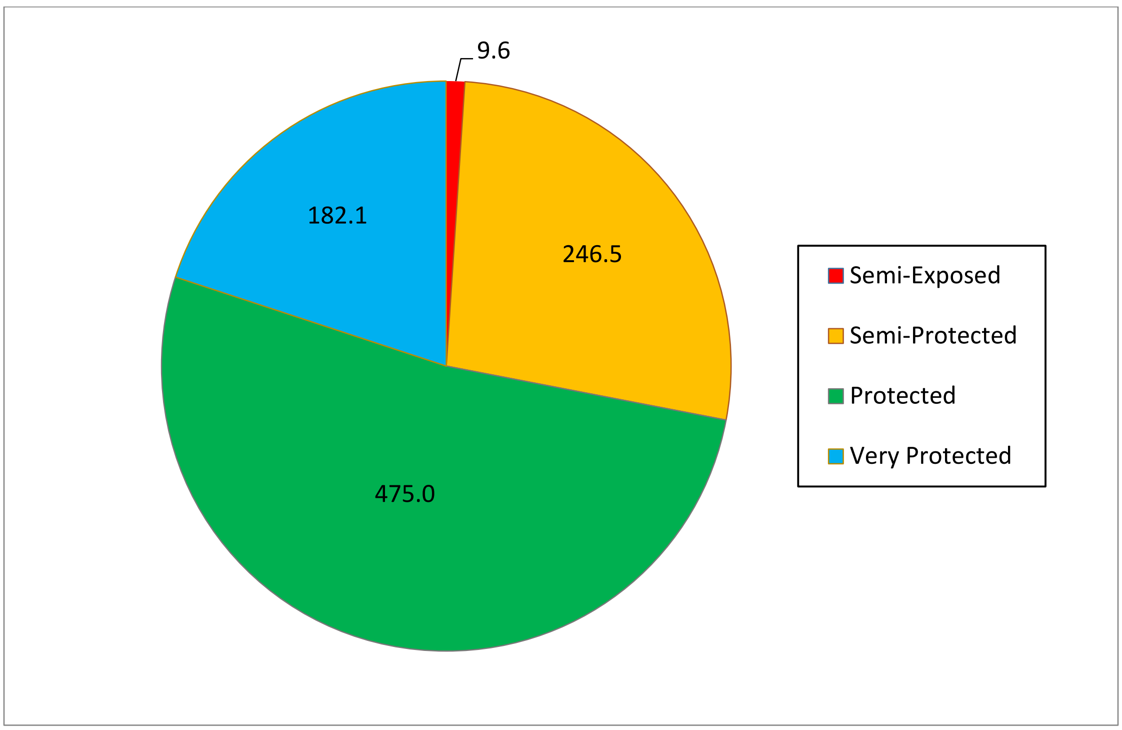

Figure 21. Distribution of biological wave exposures mapped in the Howe Sound/Vancouver Port survey area by shoreline length (km).

Figure 22. Distribution of the Biological Wave Exposure in the Howe Sound/Vancouver Port survey area.

3.3 Habitat Class

The **Habitat Class** attribute is based on wave exposure and geomorphic characteristics observed on an alongshore unit. The habitat class is intended to provide a single attribute to characterize the biophysical features of each unit. The habitat class is assigned by the biological mapper and weighted according to the dominant structuring process. Wave exposure is the most common structuring process, with less commonly observed habitats are those structured by current, estuarine/fluvial processes, and anthropogenic structures. For habitat classes structured by wave exposure, substrate mobility determines the presence of epibenthic biota. Where the substrate is highly mobile, biota is sparse or absent, and where the substrate is stable, biota can be abundant. For further definitions and explanations of Habitat Class codes please see the most recent ShoreZone protocol (Cook *et al*. 2017).

The distribution of habitat class categories mapped for the Howe Sound/Vancouver Port area are summarized in Figures 23 and 24. Partially Mobile and Immobile substrate classes are the dominant shoreline types (60.8%) with Anthropogenic habitat classes somewhat less common (19.2%). These anthropogenic habitat classes included both areas with anthropogenic structures and areas where the natural sediment in the supratidal or intertidal had been significantly moved or altered, thereby affecting the biota present or the distribution of the biota in the unit. The Riparian, or Estuary, Habitat Class was quite rare (2.2% of the shoreline length) and is characterized by a significant source of fresh water flowing into the unit, the presence of a delta fan and the presence of marsh habitat (the Salt Marsh bioband).

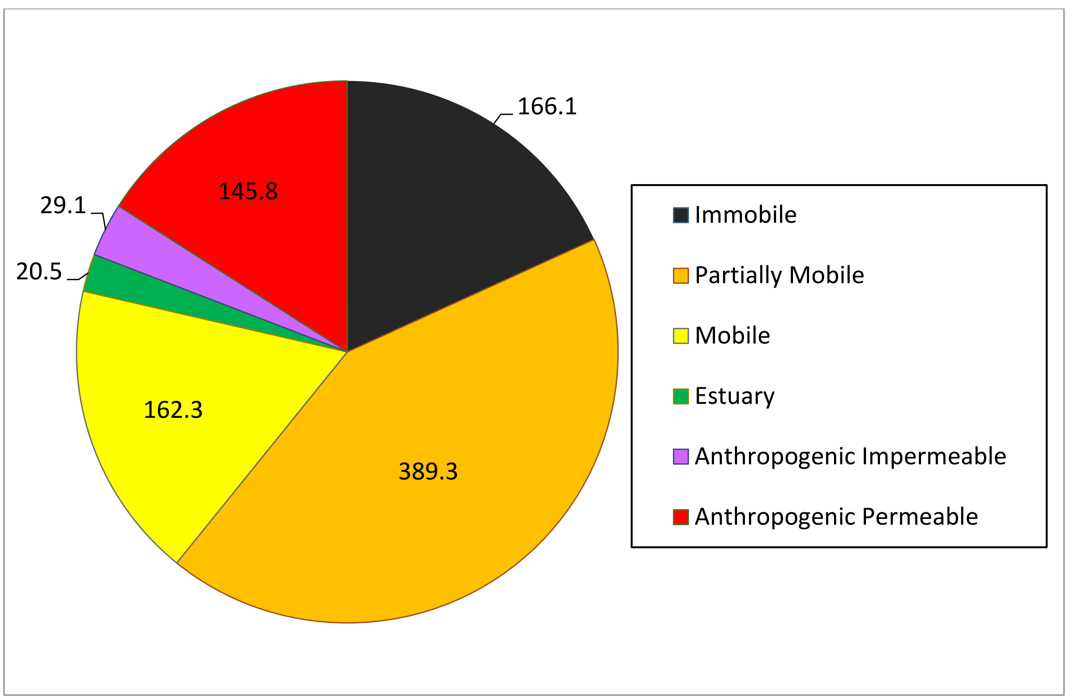

Figure 23. Distribution of Habitat Class categories in the Howe Sound/Vancouver Port survey area by shoreline length (km).

Figure 24. Distribution of Habitat Class categories in the Howe Sound/Vancouver Port survey area.

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Protocols for data access and distribution are established by the program partner agencies. Please see www.ShoreZone.org for a list of partner agencies and related web sites for the US ShoreZone. Video imagery can be viewed and digital stills downloaded online at www.ShoreZone.org and Coastal and Ocean Resources' ArcGIS site. Any hardcopies or published data sets utilizing ShoreZone products shall clearly indicate their source. For questions regarding the protocols or information in this report, please contact Sarah Cook, General Manager of Coastal and Ocean Resources at Sarah@coastalandoceans.com (250-658-4050). For data requests or analytical support contact Kalen Morrow at Kalen@coastalandoceans.com.

APPENDIX A

Photographic Examples of Coastal Classes and Biobands

Table A-1. Examples of the Coastal Classes in the Vancouver survey area (Page 36).
Table A-2. Examples of the most common Biobands in the Vancouver survey area (Page 41).

Table A-1. Examples of the Coastal Classes in the Vancouver survey area.

Photo bc18_vr_00044: Example of Coastal Class 3; Rock Cliff.
Preston Island.

Photo bc18_vr_00748: Example of Coastal Class 8; Cliff with gravel beach.
Gambier Island.

Photo bc18_vr_00315: Example of Coastal Class 11; Ramp with gravel and sand beach, wide. Keats Island.

Photo bc18_vr_01932: Example of Coastal Class 14; Ramp with gravel and sand beach, narrow. Thornbrough Channel.

Photo bc18_vr_00399: Example of Coastal Class 25; Sand and gravel beach.
Gibsons.

Photo bc18_vr_00524: Example of Coastal Class 24; Sand and gravel flat or fan.
Hopkins Landing.

Photo bc18_vr_07364: Example of Coastal Class 28; Sand flat.
Semiahmoo Bay.

Photo bc18_vr_08608: Example of Coastal Class 29; Mudflat.
Ewen Slough.

Photo bc18_vr_02541: Example of Coastal Class 31; Organics/Fines.
Squamish Harbour.

Photo bc18_vr_01874: Example of Coastal Class 32; Man-made, permeable.
Port Mellon.

Table A-2. Examples of the common biobands in the Vancouver Port region.

Photo bc17_br_00075: Good example of the Black Lichen (BLLI) bioband which is a black band in the supratidal zone, usually caused by the lichen *Verrucaria* sp. Near Point Atkinson.

Photo bc17_br_00015: Good example of the Lichen (LICH) bioband which in this case is a pinkish-orange band that occurs with the Black Lichen band. Near Point Atkinson

Photo bc17_br_00166: Good example of the Dune Grass (DUGR) bioband as a narrow blue-green strip at the top of the beach.

Photo bc18_vr_02540: Good example of the Salt Marsh (SAMB) bioband. Squamish River estuary.

Photo bc18_vr_01277: Good example of the Barnacle (BARN) bioband in the high intertidal and mid intertidal. It appears white and beige in the upper intertidal and yellowish in the mid to low intertidal Gambier Island.

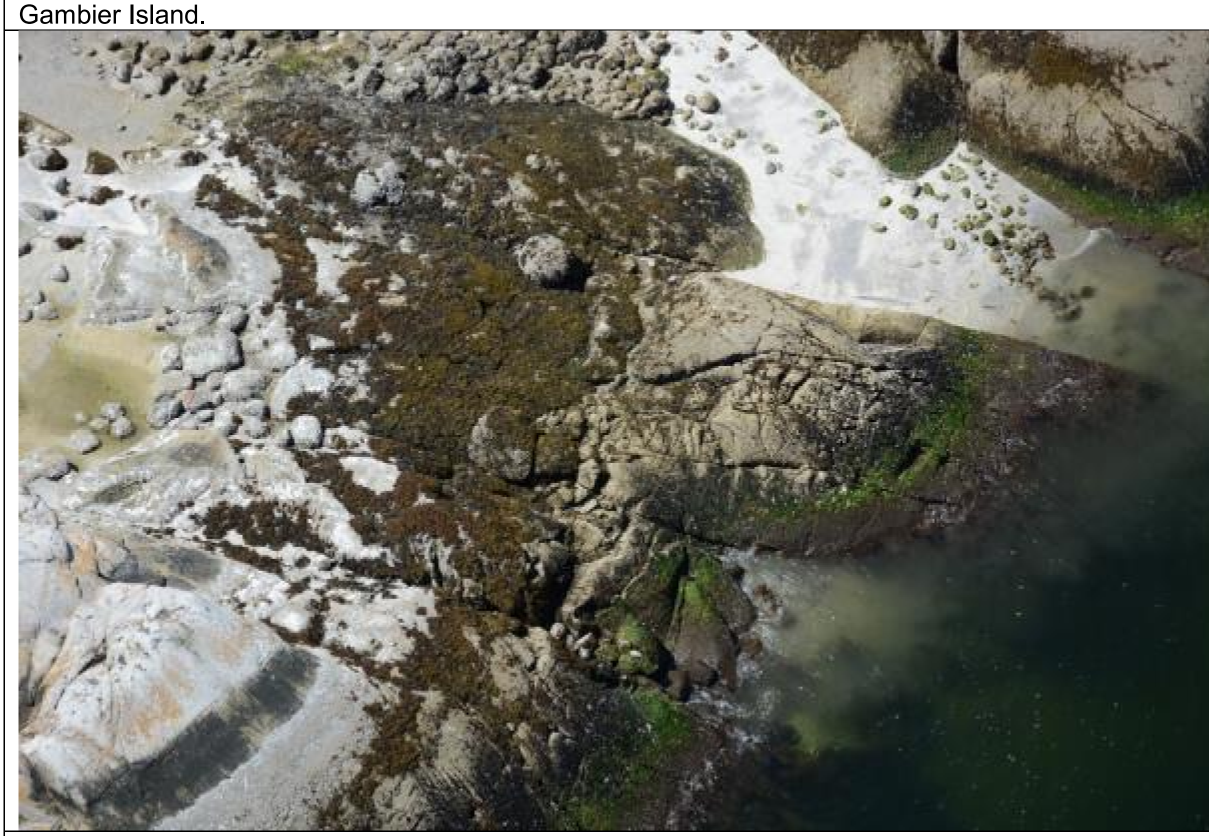

Photo bc17_br_01946: Good example of the Rockweed (ROCK) bioband in the upper intertidal. Indian Arm near Deep Cove.

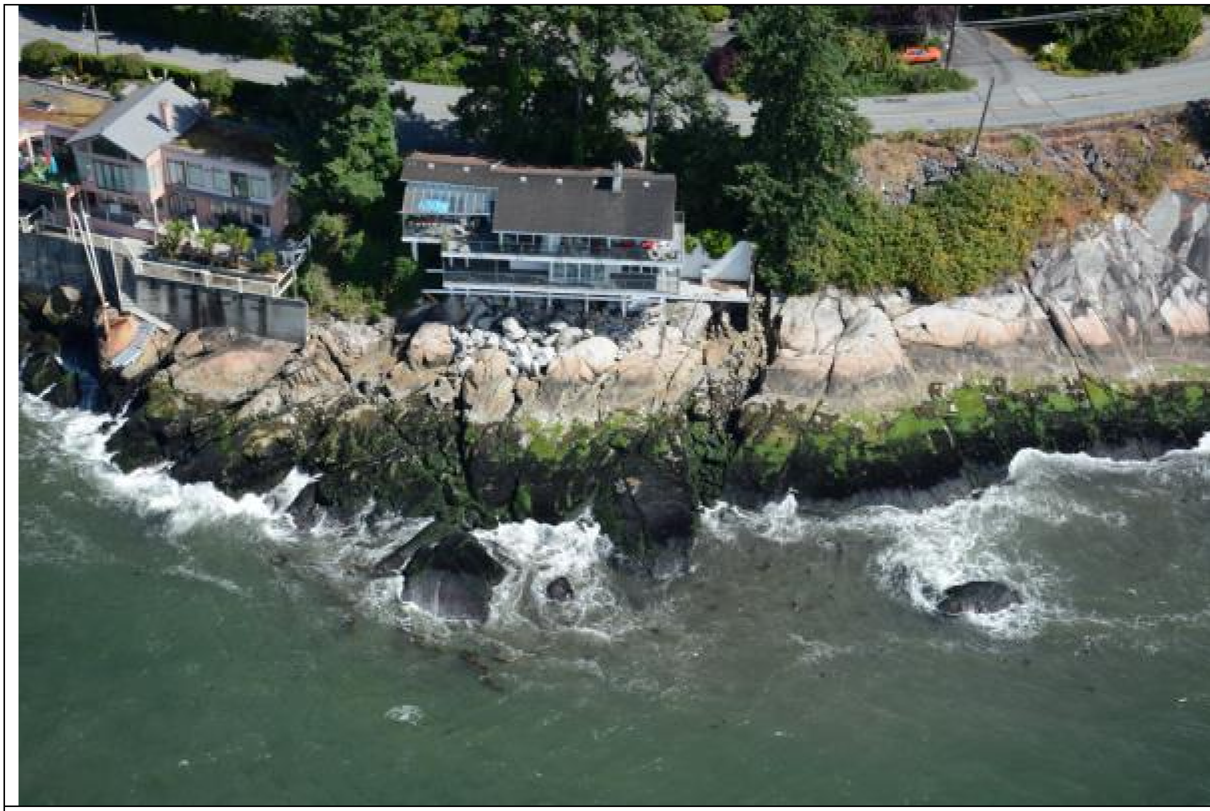

Photo bc17_br_00068: Good example of the black, velvety Blue Mussel (BLMU) bioband in the mid- to lower intertidal. Burrard Inlet.

Photo bc17_br_00113: Good example of the Green Algae (GRAL) bioband in the mid- to lower intertidal. Burrard Inlet.

Photo bc18_vr_00497: Example of the Filamentous and Foliose Red Algae (FFRA) bioband in the mid intertidal below the Blue Mussel band. Near Gibsons, Howe Sound

Photo bc17_br_01899: Good example of the Brown Bladed Algae (BRBA) bioband in the lower intertidal, right at the waterline. Entrance to Indian Arm.

Photo bc18_vr_06775: Good example of the thick Eelgrass (EELG) bioband, on a tidal flat. *Zostera japonica* and *Z. marine* were both noted here during the ground survey. Delta.

Photo bc18_vr_00907: Good example of the Sargassum (SARG) bioband as a narrow strip of brown in the shallow subtidal. This bioband is characterized by a 'fluffy' crown floating on the surface. Gambier Island.

Photo bc17_br_01007: Example of the Bull Kelp (BUKE) bioband in shallow subtidal. Near Iron Workers Memorial Bridge.